

WCES-2010

# The views of the 8<sup>th</sup> grade students about nature of scientific knowledge

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Received November 9, 2009; revised December 10, 2009; accepted January 21, 2010

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## Abstract

This study aims to investigate the 8<sup>th</sup> grade students' view about the features of scientific knowledge considering the effect of gender and the students' residence. The total number of 189 students from randomly chosen schools in three different settlements of Eskişehir, Turkey participated in the study. Students' views of the nature of scientific knowledge was assessed by the Nature of Science Knowledge Scale (NSKS). MANOVA was used to analyze the data. Results indicated that students generally hold double-minded and unsatisfactory views on the nature of scientific knowledge. Additionally, results revealed statistically significant differences in the students' perceptions of nature of scientific knowledge by gender.

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**Keywords:** Nature of science; scientific knowledge; student view; gender; students' residence.

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## 1. Introduction

The comprehension of the nature of science (NOS) and the characteristics of scientific knowledge recently have received considerable attention for learning and teaching of science (Akerson, A.B.D.-El-Khalick & Lederman, 2000; Morrison & Lederman, 2003; Tao, 2003; Schwartz, Lederman & Crawford, 2004; Kang, Scharman, & Noh, 2005; cited in Kılıç, Sungur, Çakıroğlu and Tekkaya, 2005). It is likely that the nature of science becomes a global framework of learner's total scientific knowledge (Hamrich, 1997). In parallel to this idea, one of the most important objectives for science education in many countries is defined as the development of valid understanding of the nature of science (Çelikdemir, 2006).

The Nature of Science (NOS) has been defined in numerous ways over the years, but there is a common theme within the varied definitions. In particular, the nature of science typically refers to "the values and assumptions inherent to science, scientific knowledge and/or the development of scientific knowledge" (Lederman, 1992). The importance of scientific science comes out at this point.

The aspects of the nature of science are explained by Lederman, Abd-El-Khalick, Bell and Schwartz (2002) as below:

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1. Nature of scientific knowledge is empirical.
2. There are observations, inferences, and theoretical entities in science.
3. Scientific knowledge is subjective.
4. Nature of scientific knowledge is creative and imaginative.
5. Scientific knowledge has got the social and cultural embeddedness.
6. Nature of scientific knowledge is tentative.
7. Theories and laws are different kinds of scientific knowledge both in meaning and function.

The literature shows that relatively little attention has been paid to elementary-aged students' views about the NOS (Lederman and O'Malley, 1990 & Kang, Scharmann and Noh, 2005). The situation is also same for Turkey (Çelikdemir, 2006). There have been a few studies about students' views of the nature of scientific knowledge. Results of these studies revealed that the majority of Turkish elementary school students held traditional views on some aspects of the nature of science. Many of the students had the idea that there is certain and defined scientific method in order to develop scientific knowledge (Kılıç, Sungur, Çakıroğlu and Tekkaya, 2005; Ünal-Çoban & Ergin, 2008; Bülbül and Küçük, 2007).

Turkish national curriculum has emphasized that “all students, regardless of individual and cultural differences, should develop scientific and technological literacy” (Ministry of National Education [MONE], 2004). Among the central components of scientific and technological literacy as defined in the Turkish national curriculum is an understanding of the nature and development of scientific knowledge, and of the interactions between science, technology, and society (Abd-El-Khalick and Doğan, 2008). The research shows in Turkey (Çelikdemir, 2006; Doğan-Bora, 2005) and abroad (Carey and Smith, 1993; Moss, Abrams and Robb, 2001; Zeidler, Walker, Ackett and Simmons, 2002) that the students do not have enough scientific knowledge.

Beyond having done a few studies about students' views of the nature of scientific knowledge, this mentioned studies mainly focused on high school students' views. Beside these, Turkish literature there are a few studies assessing results according to students' gender (e.g., Kılıç et al., 2005) and students' residence (e.g., Abd-El-Khalick and Doğan, 2008). At that respect, this study focuses on elementary-aged students' views considering both gender and the students' residence. Results of this study will contribute to the existing literature providing deep look to the students background characteristics at the 8<sup>th</sup> grade.

## 2. Method

### 2.1. Sample

Two inner city, two district and four village schools were randomly selected, ultimately eight public schools participated in the study. Total number of 189 eight grade students located in twelve classes were surveyed. The sample consisted of 93 (49,2 %) girls and 96 (50,8 %) boys. Classes distribution over the schools are as following four classes from inner city schools, four classes from district schools and four classes from village schools.

### 2.2. Instrument

All students answered the Nature of Science Knowledge Scale (NSKS) (Ünal-Çoban and Ergin, 2008) The NSKS covers three tenets of nature of scientific knowledge which is characterized as following three factors “Scientific Knowledge is Closed (8 items), Scientific Knowledge is Justified (5 items), Scientific Knowledge may Change (3 items)”. It is a 5-Likert-type scale ranging from strongly agree to strongly disagree with 16 items in total (see Table 1). The reliability of the factors were found as 0.70; 0.67 and 0.65 respectively and the reliability of the whole instrument was found to be 0.80.

Table 1 .Scales, sample item, reliability (alpha) of NKS

Scale	Sample Items	SD	Alpha	Mean
Scientific Knowledge is Closed	Scientific knowledge is always true.	4.77	0.70	20.16
Scientific Knowledge is Justified	Before beginning an experiment, it is a necessity to get information about the subject.	4.86	0.67	18.90
Scientific Knowledge may Change	Scientific knowledge can change in time.	3.10	0.65	9.89

For analyzing the data relating with the scale, the spaces of five point Likert-type scale 0.80 ( $5-1=4 \rightarrow 4/5=0.80$ ) are decided as the equal spaces as following: Strongly agree 4.20 – 5.00, Agree 3.40 – 4.19, Not sure 2.60 – 3.39, Disagree 1.80 – 2.59 and Strongly disagree 1.00 – 1.79.

### 2.3 Analyses

In order to answer the research question, a number of analyses were performed. Firstly, mean, standard deviation, were computed, then multi variance analysis (MANOVA) was performed.

Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variances covariance matrices and multicollinearity, with no serious violations noted.

### 3. Results (Findings)

Descriptive analysis in Table 1 indicated that 8<sup>th</sup> grade students hold neither traditional nor contemporary view but unsatisfactory view on the nature of scientific knowledge (mean= 3,21). Basically, the students do not sure what the nature of scientific knowledge means. A changeable tenet of the NSKS has the highest mean score ( $\bar{X}=4,13$ ), however closed tenet has the lowest mean score ( $\bar{X}=2,43$ ). Generally, participants believed that scientific knowledge was capable of empirical test and also agreed that scientific knowledge was certain, correct and authority-based. But, they were hesitant toward the statement of “scientific knowledge was changeable”.

Table 2. Means and standard deviation of the tenets of NSKS by gender and settlement types

	Gender						Settlement Types										Total	
	Male			Female			Centre			District			Village					
	N	$\bar{X}$	S	N	$\bar{X}$	S	N	$\bar{X}$	S	N	$\bar{X}$	S	N	$\bar{X}$	S	N	$\bar{X}$	S
Closed knowledge	96	18,72	4,58	93	20,31	4,74	75	19,88	4,81	70	19,95	4,66	44	18,15	4,48	189	19,50	4,71
Justified knowledge	96	20,32	3,12	93	21,00	2,56	75	20,37	3,29	70	21,02	2,34	44	20,54	2,88	189	20,65	2,87
Changeable knowledge	96	11,33	2,54	93	11,10	2,79	75	11,54	2,75	70	11,08	2,65	44	10,88	2,53	189	11,22	2,66

In Table 2, descriptive analysis shows that the students’ views on the tenets of NSKS by gender and settlement types. It is observed that the means of female students regarding “closed” tenet are higher than the male ones. Concerning attended settlement type, it can be said that the students’ means in the villages are a little lower than the others.

A two-way multivariate analysis of variance (MANOVA) was conducted to figure out whether the means of the tenets of NSKS significantly differed with regard to gender and the students’ residence at 0.05 significance level. It was found that the interaction between gender and the place students live has not a significant effect on the dependent variables [Wilk’s Lambda ( $\Lambda$ )=.994 F(6, 362)=.185  $p>.05$ ]. It is also found that the effect of gender [Wilk’s Lambda ( $\Lambda$ )=.932 F(3, 181)= 4.42  $p<.01$ ] was significant but the place students live [Wilk’s Lambda ( $\Lambda$ )=.934 F(6,362)=2,10  $p>.05$ ] was not significant. In other words, there were significant mean differences between the males and females but not among the students’ residence.

The results in which tenets there have been differences were given in Table-3. Concerning gender difference and the means in Table-2 there are also significant differences about “closed knowledge” tenets of NSKS.

Table 3. MANOVA analysis on the tenets of NSKS by gender and settlement types

Source	Dependent Variable	sd	F	$\eta^2$	p
Gender	Closed Knowledge	1	5.269	2.529	.023*
	Justified Knowledge	1	3.446	1.213	.065
	Changeable Knowledge	1	.368	.823	.545
Settlement Type	Closed Knowledge	1	2.537	2.529	.082
	Justified Knowledge	1	1.215	1.213	.299
	Changeable Knowledge	1	1.055	.823	.350
Gender * Settlement Type	Closed Knowledge	1	.300	2.529	.741
	Justified Knowledge	1	.175	1.213	.840
	Changeable Knowledge	1	.023	.823	.977

\*  $p < 0.05$ 

The means and standard deviations of three tenets of the scale and one way ANOVA results concerning gender differences were shown in Table 4. According to gender differences, the one way ANOVA for “closed” ( $F(1,187)=5.441$ ,  $p=.021$ ) tenet of the NSKS were significant in favors of the girls. But, “justified” and “changeable” tenets were not significant ( $p>0.05$ ). The mean scores displayed in Table 3 indicated that girls had higher scores on “closed” tenet of the NSKS.

Table 4. The means and standard deviations of three tenets of the scale and one way ANOVA results

Tenet	$\bar{X}$	sd	F	p
Closed Knowledge	19,50	4,71	5,441	,02
Justified Knowledge	20,65	2,87	2,642	,106
Changeable Knowledge	11,22	2,66	,338	,562

#### 4. Discussion

Students hold neither traditional nor contemporary view but unsatisfactory view on the nature of scientific knowledge. In literature, there are findings which the students have traditional and contemporary views about scientific knowledge. For example, in Chuang (1999)’s study, the students have contemporary view. In Doğan-Bora (2005), the students also agree with the idea that scientific knowledge is tentative. But, there are also studies that the students do not have a contemporary views on scientific knowledge (Carey, 1989; Dagher, 2004; Kılıç, Sungur, Çakıroğlu, & Tekkaya, 2005; Chuang, 1999).

Generally, participants believed that scientific knowledge was capable of empirical test and also agreed that scientific knowledge was certain, correct and authority-based. But, they were hesitant toward the statement of “scientific knowledge was changeable”. This finding is parallel with the findings of Ke-Sheng Chan (2005) and Muşlu (2008) studies. In the forementioned studies, there is also a negative, seesawing at-a-distance type of interconnection between some conceptions of scientific knowledge.

A two-way multivariate analysis of variance (MANOVA) was conducted to determine the effect of gender and the place students live on three tenets of nature of scientific knowledge: closed, justified and changeable at 0.05 significance level. Gender was found to have significant effect on the dependent measures [Wilk’s Lambda ( $\Lambda$ )= .932  $F(3, 181)= 4.42$   $p<.01$ ]. But, students’ residence was found to have not significant effect on the dependent measures [Wilk’s Lambda ( $\Lambda$ )= .934  $F(6,362)=2,10$   $p>.05$ ]. Eskisehir, where applications have been done, is the city that graduation rate, education level and education quality is higher than national average rates. Moreover, there is no big gap among the residences in Eskisehir. It can be the reason of results about residence, that is why might be no difference. No interaction were found between gender and the place students live [Wilk’s Lambda ( $\Lambda$ )= .994  $F(6, 362)= .185$   $p>.05$ ].

## 5. Conclusion and Recommendation

This study is a debut for understanding of the students' nature of scientific knowledge considering the gender and students residence. Results of the study indicated that “the students are double-minded about the nature of scientific knowledge”. The students are standing somewhere between having modern and traditional scientific ideas, in other words, they have inadequate understanding. It is clear from the study that students have misconceptions on the nature of science. For destroying this misconceptions, the lessons should be planned in the way of providing students develop their own scientific knowledge. Moreover, much as there are activities in science curriculum about nature of science, the research shows that there should be more activities in the curriculum. For example, the teachers can design projects about NOS and also use different methods while organizing their intraclass activities. Certainly adequate understandings of NOS are necessary for teachers to be able to teach about NOS to their students. However, teachers must also recognize that NOS is important for their students. Not only students but also teachers must know the necessity of NOS. So, in-service training should be given to the science and technology teachers.

This study was subject to some limitations. The sample of this study is small and data collected only in Eskisehir, a province in Turkey. Future study with large sample and different variables like socioeconomic (SES) and students's background characteristics could give more information about the effects of students' residence. The information that was obtained in this study has been limited to grade 8 students. The research can encourage others to brode the sample different parts of educational levels by gaining insight about students' science perception.

Finally, the present study can serve as a valuable comparative reference for future studies in Turkey for curriculum studies and programme evlopment.

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